Russians are the fastest and the youngest in the "Comrades Marathon"

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Abstract: The present retrospective study intended to determine age, performance, the role of nationality and participation trends across calendar years in runners competing in "Comrades Marathon", the ultra-marathon with the longest tradition and the highest number of finishers worldwide. We analysed 235,467 finishers (40,211 women and 195,256 men) competing between 1994 and 2017. In women and men, Russians were the fastest (12.55 ± 2.03 km/h and 12.24 ± 2.93 km/h, respectively) and Indians the slowest (7.87 ± 0.64 km/h and 7.91 ± 0.60 km/h) ($p < 0.001$, $\eta 2 = 0.053$ and $\eta 2 = 0.010$, small effect size, ES). Also, Russians were the youngest (33.9 ± 4.6 and 36.3 ± 5.9 years, respectively) and Japanese the oldest (49.3 ± 9.6 and 51.4 ± 12.3 years, respectively) ($p < 0.001$, $\eta 2 = 0.011$, small ES). Performance improved ($r = 0.90$ in women and $r = 0.92$ in men), age of finishers ($r = 0.91$ in women and $r = 0.97$ in men), participation ($r = 0.92$ in women and $r = 0.87$ in men) and sex difference in age increased ($r = 0.71$), whereas men-to-women ratio ($r = -0.91$) and sex difference in performance ($r = -0.68$) decreased across calendar years ($p < 0.001$). In summary, runners from Russia were the fastest and the youngest in both sexes. The knowledge of the relationship of nationality with performance, age and participation trends of finishers, and changes across calendar years are of practical importance for ultra-runners and coaches working with them.

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Russians are the fastest and the youngest in the 'Comrades Marathon'

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ABSTRACT

The present retrospective study intended to determine age, performance, the role of nationality and participation trends across calendar years in runners competing in 'Comrades Marathon', the ultra-marathon with the longest tradition and the highest number of finishers worldwide. We analysed 235,467 finishers (40,211 women and 195,256 men) competing between 1994 and 2017. In women and men, Russians were the fastest (12.55±2.03 km/h and 12.24±2.93 km/h, respectively) and Indians the slowest (7.87±0.64 km/h and 7.91±0.60 km/h) ($p<0.001$, $\eta^2=0.053$ and $\eta^2=0.010$, small effect size, ES). Also, Russians were the youngest (33.9±4.6 and 36.3±5.9 years, respectively) and Japanese the oldest (49.3±9.6 and 51.4±12.3 years, respectively) ($p<0.001$, $\eta^2=0.011$, small ES). Performance improved ($r=0.90$ in women and $r=0.92$ in men), age of finishers ($r=0.91$ in women and $r=0.97$ in men), participation ($r=0.92$ in women and $r=0.87$ in men) and sex difference in age increased ($r=0.71$), whereas men-to-women ratio ($r=-0.91$) and sex difference in performance ($r=-0.68$) decreased across calendar years ($p<0.001$). In summary, runners from Russia were the fastest and the youngest in both sexes. The knowledge of the relationship of nationality with performance, age and participation trends of finishers, and changes across calendar years would be of practical importance for ultra-endurance runners and coaches working with them.

Key words: age, performance, ultra-endurance, running

INTRODUCTION

The 'Comrades Marathon', distance ~90 km, is the largest (in terms of participants and finishers) ultra-marathon in the world with the longest tradition. This ultra-marathon has been studied with regards to its metabolic impact (McKechnie, Leary, & Noakes, 1982), relationship with musculoskeletal injuries (Hagemann, Rijke, & Corr, 2008), economic impact (Shipway, Kirkup, Saayman, & Saayman, 2012), participants' motivation (Kruger & Saayman, 2013) and the age of peak performance (APP) (Knechtle & Nikolaidis, 2017). A recent study investigating the age of peak ultra-marathon performance in the 'Comrades Marathon' showed an older APP than in marathon running and that most finishers were from South Africa (Knechtle & Nikolaidis, 2017) . However, the potential role of nationality for the performance and age of finishers has not been investigated and no information is available on trends of performance and age across calendar years in this race.

For athletes and coaches it would be useful to know whether the local South Africans were the youngest and the fastest, which could be hypothesized based upon existing findings for East African marathoners (Aschmann et al., 2013; Knechtle et al., 2017; Knechtle et al., 2016; Nikolaidis, Onywera, & Knechtle, 2017). Furthermore, the knowledge about trends in participation, performance, age of finishers and sex differences in these characteristics across calendar years is expected to help coaches developing long-term training programs and setting goals. For instance, a potential excellence of a particular nationality in the 'Comrades Marathon' is information of practical relevance for runners during the race.

99 Therefore, the aim of the present study was to examine the relationship of nationality
100 with race time and age of finishers in the Comrades. Based upon existing findings we
101 hypothesized that local athletes (*i*) represent the largest percentage of finishers, (*ii*) are
102 the fastest overall, and (*iii*) are the youngest for both women and men, and (*iv*) that
103 the number of finishers increases and performance improves across calendar years.

METHODS

Ethical approval

The Institutional Review Board of Kanton St. Gallen, Switzerland approved all procedures used in the study with a waiver of the requirement for informed consent of the participants given the fact that the study involved the analysis of publicly available data (01/06/2010). The study was conducted in accordance with recognised ethical standards according to the Declaration of Helsinki adopted in 1964 and revised in 2013.

Data

The 'Comrades Marathon' has been held since 1921 (www.comrades.com). The organizer of the race is the 'Comrades Marathon' Association (CMA). The race is held annually in the KwaZulu-Natal Province of South Africa between the cities of Durban and Pietermaritzburg and it is a national sporting event broadcast in full on television. The direction of the race alternates each year between the 'up' run covering 87 km and starting from Durban and the 'down' run covering 89 km and starting from Pietermaritzburg. The time limit for the ~90 km route is 12:00 h:min. Any runner can compete in the race but all entrants must comply with the qualifying criteria (www.comrades.com/events/qualifying-races), *i.e.*, a previous achievement of marathon race time of 5:00 h:min or a 100-km ultra-marathon race time of 13:30 h:min. In order to investigate the APP by nationality in the 'Comrades Marathon', we considered all finishers in the race regarding their nationality, sex, age, and race time. We analysed 235,467 finishers (40,211 women, 17.1%; 195,256 men, 82.9%), where the overall men-to-women ratio was 4.86. We considered athletes from nationalities

129 with at least 0.001% finishers, whereas nationalities with lower participation were
130 grouped into 'Other'.
131
132 **Procedures**
133 Race times, sex, nationality and ages of runners for the period 1994-2017 were
134 retrieved from the website http://statistik.d-u-v.org of DUV (Deutsche Ultramarathon
135 Vereinigung). Data were not from the official website www.comrades.com, because
136 the age of the runners is not recorded on the website of 'Comrades Marathon'. Data
137 for 'Comrades Marathon' before 1994 were not available on http://statistik.d-u-v.org.
138 Since the 'Comrades Marathon' is held in two different directions each one with
139 different distance, we calculated running speed (km/h) using race distance (km) and
140 race time (h:min:sec) for each direction. For each nationality, we calculated the
141 number of men and women, and determined the men-to-women ratio (MWR) by
142 dividing the number of men by the number of women.
143
144 **Statistical analyses**
145 The acceptable type I error was set at $p<0.05$. All data are presented as means and
146 standard deviations. Figures were created using GraphPad Prism v. 7.0 (GraphPad
147 Software, San Diego, USA); all other statistical analyses were carried out using IBM
148 SPSS v.23.0 (SPSS, Chicago, USA). Normality was tested using the Kolmogorov-
149 Smirnoff test and visual inspection of normal Q-Q plots. We examined the men-to-
150 women ratio in all finishers and separately for each nationality. The sex×nationality
151 association, *i.e.* whether the men-to-women ratio differed by nationality, was
152 examined using the chi-square (χ^2), and the magnitude of this association was
153 evaluated by Cramer's phi (φ). The Student's T-test was used to examine sex
154 differences in speed and age, and the magnitude (effect size, ES) of these differences

was estimated by Cohen's d. A between-within subject analysis of variance (ANOVA) examined the main effect of nationality and the sex×nationality interaction on speed and age, and the magnitude of differences was tested using eta square (η^2). It should be highlighted that the "main effect" used in the Methods and Results sections of this paper consists a strict statistical term and does not imply the study of any cause-effect relationship among the variables. Percentage sex difference in speed among nationalities was calculated using the formula 100×(speed in men-speed in women)/speed in men. Furthermore, χ^2 was used to examine the sex×calendar year association, i.e. whether the men-to-women ratio varied by calendar year. A between-within subject ANOVA examined the main effect of calendar year and the sex×calendar year interaction on speed and age. Linear regression analysis examined trends of participation, age and performance across calendar years. Pearson correlation coefficient r was used to examine the relationship of calendar year with number of finishers, running speed, age and sex differences. The APP considering age groups in 1-year intervals was calculated using a non-linear regression model with a second order (*i.e.* quadratic) polynomial function ($y=ax^2+bx+c$) that fitted the data. The vertex of the quadratic function was calculated as $p(x|y) = (-\frac{b}{2a} \mid C - \frac{b^2}{4a})$. We determined the age with the fastest speed for both the fastest (top 10) women and men and all women and men in 1-year age intervals.

RESULTS

Participation and performance by nationality

The overall men-to-women ratio was 4.86 (Table 1). Most finishers were local athletes from South Africa (93.4%). An association of sex with nationality was observed (χ^2=628.7, p<0.001, φ=0.052), where the men-to-women ratio ranged from 1.39 (Russia) to 23.60 (Lesotho).

Men were faster by 8.4% or 0.70 km/h (95% CI 0.69, 0.72; 9.12±1.48 km/h *versus* 8.42±0.97 km/h, respectively, p<0.001, d=0.56, medium ES) and older by 0.5% or 0.2 years (95% CI 0.1, 0.3; 40.3±9.0 years versus 40.1±7.9 years, respectively, p<0.001, d=0.02, trivial ES) than women.

A trivial main effect of nationality on running speed was observed (p<0.001, η^2=0.008) where athletes from Russia were the fastest and athletes from India the slowest. A trivial sex×nationality interaction on running speed was found (η^2=0.001, p<0.001) with sex difference ranging from -2.5% (Russia) to 30.2% (Lesotho) (Figure 1). In women, athletes from Russia were the fastest (12.55±2.03 km/h) and athletes from India the slowest (7.87±0.64 km/h) (p<0.001, η^2=0.053, small ES); Russians were faster than Indians by 4.68 km/h (95% CI 3.98, 5.38). In men, athletes from Russia were the fastest (12.24±2.93 km/h) and athletes from India the slowest (7.91±0.60 km/h) (p<0.001, η^2=0.010, small ES), too; Russians were faster than Indians by 4.32 km/h (95% CI 3.95, 4.70).

A trivial main effect of nationality on age was observed (p<0.001, η^2=0.006) runners from Russia were the youngest and runners from Japan were the oldest. A trivial sex×nationality interaction on age was found (η^2<0.001, p<0.001) with sex difference

ranging from -1.3% (Swaziland) to 12.8% (Netherlands) (Figure 2). In women, athletes from Russia were the youngest (33.9±4.6 years) and athletes from Japan the oldest (49.3±9.6 years) ($p<0.001$, $\eta^2=0.011$, small ES); Russians were younger than Japanese by 15.4 years (95% CI 13.3, 17.5). In men, athletes from Russia were the youngest (36.3±5.9 years) and athletes from Japan the oldest (51.4±12.3 years) ($p<0.001$, $\eta^2=0.011$, small ES), too; Russians were younger than Japanese by 15.1 years (95% CI 12.9, 17.3).

Participation and performance by calendar year

An association of sex with calendar year was observed ($\chi^2=1,793.0$, $p<0.001$, $\varphi=0.087$), where the men-to-women ratio ranged from 3.58 (2010) to 10.08 (1993) (Figure 3).

A small main effect of calendar year on age was shown ($p<0.001$, $\eta^2=0.017$) (Figure 4) that ranged from 35.7±7.5 years (1993) to 42.01±8.8 years (2016). A trivial sex×calendar year interaction on age was found ($p<0.001$, $\eta^2=0.001$) with sex difference varying from -0.5% (*i.e.* women were older; 1993) to 3.7% (*i.e.* men were older; 2017).

A small main effect of calendar year on running speed was shown ($p<0.001$, $\eta^2=0.034$) (Figure 5) with running speed decreasing from 1994 (10.17±1.61 km/h) to 2015 (8.43±1.23 km/h). A trivial sex×calendar year interaction on running speed was found ($p<0.001$, $\eta^2=0.001$) with sex difference decreasing from 11.7% (1994) to 6.2% (2015). The differences in running speed among calendar years were in agreement with the linear regression analysis which showed large to almost perfect relationship of calendar year with running speed in women ($r=-0.90$), men ($r=-0.92$) and sex difference ($r=-0.68$, $p<0.001$).

Age of peak performance

When all finishers were considered, the APP was 36 years in women and 29 years in men with the sex difference ranging from 1.7% (64 years) to 12.3% (29 years) (Figure 6). When the top 10 finishers per age group were analyzed, the APP was 38.3 years in women (corresponding running speed 12.97 km/h) and 36.0 years in men (corresponding running speed 15.54 km/h) with sex difference ranging from 14.8% (44 years) to 45.0% (23 years). Furthermore, it was highlighted that sex difference across lifespan in all finishers not only differed from that in top 10 finishers, but presented different trends; the sex difference decreased continuously across age in the first case, whereas it presented a "U" shape in the second case.

DISCUSSION

The main findings of the present study were that (*i*) the men-to-women ratio differed by nationality (lowest in athletes from Russia and highest in athletes from Lesotho); (*ii*) men were faster and older than women; (*iii*) runners from Russia were the fastest and the youngest, whereas runners from India were the slowest and runners from Japan the oldest; (*iv*) the men-to-women ratio and the speed decreased, whereas the participation and age increased across years; (*v*) the APP was ~36 years and ~29 years in women and men, respectively.

Russians were the fastest and the youngest

An unexpected finding was that athletes from South Africa were not the fastest, although they represented the largest percentage of finishers. Based on examples of other endurance sports, such as triathlon (Dahler, Rust, Rosemann, Lepers, & Knechtle, 2014; Rust et al., 2015) and open-water swimming (Knechtle, Rosemann, & Rust, 2014) a relatively high performance of local athletes was hypothesized. On the other hand, a major finding was the dominance of Russians. To date, little is known about participation and performance trends of Russian athletes compared to athletes from other nations. A recent study - analysing the top runners in 10km, half-marathon, marathon and 100-km ultra-marathon in the list of the International Association of Athletics Federation from 1999 to 2015 - reported that Russian and Japanese men were the fastest, and Russian women were the youngest in 100-km ultra-marathon running (Nikolaidis, Onywera, et al., 2017). The superior performance of Russians in the 'Comrades Marathon' confirmed the findings of a recent analysis of ~150,000 ultra-marathoners finishing a 100-km ultra-marathon from 1959 to 2016 (Knechtle, Nikolaidis, & Valeri, 2018). These authors observed that Russians (the fastest

nationality) had a relatively high percentage (~37%) of their finishes outside of their country (the corresponding percentage in Japanese, *i.e.* another fast nationality, was ~2%). The superior performance of Russians might be explained in terms of participation and age. Although Russia has more population than countries such as United Kingdom, Australia, Germany, Canada and Suisse, a relatively smaller number of Russians finished in the 'Comrades Marathon' (**Table 1**). This indicated that Russian finishers were relatively more "selected". Furthermore, being the youngest (**Figure 2**) practically meant that their age was the closest to the APP (**Figure 6**).

It should be also highlighted that the magnitude of the relationship of nationality with performance was small in both sexes; however, the value of ES was higher in women than in men indicating a potential larger impact of nationality on performance in women compared to men. This observation implies that inter-national differences concern mostly women rather than men. On the contrary, the relationship of nationality with age had the same magnitude for both sexes. A study investigating participation and performance trends for cross-country skiers in one of the largest cross-country skiing marathons held in Europe, the 'Engadin Ski Marathon' showed that more than two-thirds of the finishers (72.5% in women and 69.6% in men) were local athletes from Switzerland, followed by skiers from Germany, Italy, and France in both sexes. Regarding performance and age, women and men from Russia were the fastest although they were only on 11th position in men and 10th in women regarding participation. Considering age, female and male skiers from Russia were the third youngest (Nikolaidis, Heller, & Knechtle, 2017). A potential explanation that female and male athletes from Russia are the youngest and the fastest in both the 'Engadin Ski Marathon' and the 'Comrades Marathon' although they do not represent the

295 nation with the highest participation could be that only the best athletes travel abroad
296 from Russia for these specific races.
297
298 ***Men-to-women ratio by nationality***
299 The MWR of all finishers was similar as that of Republic of South Africa, which
300 might be explained that this nationality consisted in more than nine out of 10
301 finishers. It was noteworthy that the MWR varied by nationality (*i.e.* lowest in
302 athletes from Russia to highest in athletes from Lesotho). This finding confirmed
303 previous research in cross-country skiing about the variation of participation rates of
304 women and men by nationality, where the MWR ranged from 2.85 (British) to 7.48
305 (Italians) (Nikolaidis, Heller, et al., 2017). The MWR is an index of great practical
306 value as it has been shown to associate with sex difference in performance (Hunter &
307 Stevens, 2013), *i.e.* the higher the MWR, the larger the sex difference. The variation
308 of the MWR by nationality was in agreement with a previous observation that the gap
309 between women's and men's participation in sports differed by ethnic groups (Peters,
310 2014). Social and economic (*e.g.* gross domestic product) differences might explain
311 the variation of the MWR by nationality (Mirsafian, 2016).
312
313 ***Changes across calendar years***
314 The MWR and race speed decreased, whereas the participation and age increased
315 across years. This is not the first study to report a relatively higher increase of women
316 participation compared to men in ultra-endurance running across years as a decreased
317 MWR in participation in the '100 km Lauf Biel' in Switzerland from 1998 to 2010 has
318 been observed (Knechtle, Rust, Rosemann, & Lepers, 2012). The relatively higher
319 increase of women participation compared to men across years might be associated

with breaking through several barriers such as a social pressure against participation for women in the past (Kleiber & Hemmer, 1981; Pate & O'Neill, 2007). Despite the decrease of the MWR across years reflecting the increase of women participation, this index remains much higher than 1.0 suggesting that socio-ecological factors at the individual, family, school and environmental levels (Telford, Telford, Olive, Cochrane, & Davey, 2016) prevent the equal participation of both sexes in the 'Comrades Marathon'.

Differences between the sexes

Overall, men were faster and older than women but the APP was younger in men (29 years) compared to women (36 years). With regards to sex differences, the magnitude of effect sizes indicated that the relationship of sex with running speed was larger than with age. The sex difference in running speed (*i.e.* men faster by 8.4%) was in line with a previous study in top 100-km ultra-marathon runners where men were faster than women (6:48:01 versus 7:53:51 h:min:sec, respectively), too (Nikolaidis, Onywera, et al., 2017). The sex difference in performance was due to differences in physiology, biomechanics, rate of participation and training characteristics (Deaner, 2013a, 2013b). With regards to the finishers' age, men were slightly (trivial ES) older than women (40.3 years versus 40.1 years, respectively). The finishers' age is older than that previously reported in top 100-km ultra-marathon runners (36.6 years in women versus 35.9 years in men) in a study reporting no sex difference in age (Nikolaidis, Onywera, et al., 2017).

A limitation of the present study was that statistical models used in the present study relied on the variables included in publicly available data; whereas future studies

345 could include more explanatory variables (*e.g.* personal best race times, training and
346 physiological characteristics). Nevertheless, the difficulty to obtain information on
347 such variables in large samples should be acknowledged. This might explain why all
348 previously published research on the nationality and ultra-marathon lacked
349 information in training and physiological characteristics (e.g. (Knechtle et al., 2018;
350 Nikolaidis, Onywera, et al., 2017)). On the other hand, studies on training and
351 physiological characteristics of ultra-marathon runners rarely used large samples
352 (Christensen et al., 2017; Da Ponte et al., 2018; Klapcinska et al., 2013) which were
353 incompatible to study the role of nationality or age. The relatively small number of
354 finishers from most nationalities did not allow the examination of a potential
355 relationship of nationality with the APP. It would be reasonable to assume that the
356 APP would vary by nationality since the age differs accordingly; however, this would
357 be interesting to be examined in future research that will consider larger data.
358
359 ## Conclusions
360
361 Strength and conditioning professionals face increasing demands in their work
362 considering the increasing rates of those participating in ultra-endurance running.
363 These professionals must be aware of characteristics of ultra-endurance runners, such
364 as participation rates, age, performance, sex differences, and changes across calendar
365 years. In this context, the findings of the present study provide practical information
366 for strength and conditioning professionals. For athletes and coaches, local athletes
367 competing in the 'Comrades Marathon' held in South Africa were not the fastest and
368 the youngest, but for both women and men, runners from Russia were the fastest and
369 the youngest. In addition, the knowledge of the APP is fundamental in order to set
370 long-term training goals. Thus, different training goals should be set depending on the
371 sex and age.

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459

Table 1 Finishers from nationalities with >0.001% of the total number of finishers

Nationality	Women	Men	Total	MWR
RSA	36,939	183,082	220,021	4.96
GBR	608	2,583	3,191	4.25
AUS	517	1,400	1,917	2.71
USA	441	1,140	1,581	2.59
ZIM	254	1,226	1,480	4.83
GER	158	734	892	4.65
BRA	164	704	868	4.29
LES	20	472	492	23.60
CAN	141	299	440	2.12
SWZ	97	327	424	3.37
NAM	117	295	412	2.52
SUI	58	301	359	5.19
IND	34	253	287	7.44
JPN	91	188	279	2.07
RUS	106	147	253	1.39
NED	39	195	234	5.00
Other	427	1910	2337	4.47
Total	**40,211**	**195,256**	**235,467**	**4.86**

MWR=men-to-women ratio, RSA=Republic of South Africa, GBR=United Kingdom, AUS=Australia, USA=United States of America, ZIM=Zimbabwe, GER=Germany, BRA=Brazil, LES=Lesotho, CAN=Canada, SWZ=Swaziland, NAM=Namibia, SUI=Switzerland, IND=India, JPN=Japan, RUS=Russia, NED=Netherlands.

Legends of figures

Figure 1 Running speed by sex and nationality. Error bars represent standard deviations. The horizontal dashed line is set at 0% of sex difference (right y axis).

Figure 2 Age by sex and nationality. Error bars represent standard deviations. The horizontal dashed line is set at 0% of sex difference (right y axis).

Figure 3 Finishers by calendar year. MWR=men-to-women ratio. All r-values are at $p<0.001$. The dashed lines represent 95% confidence intervals.

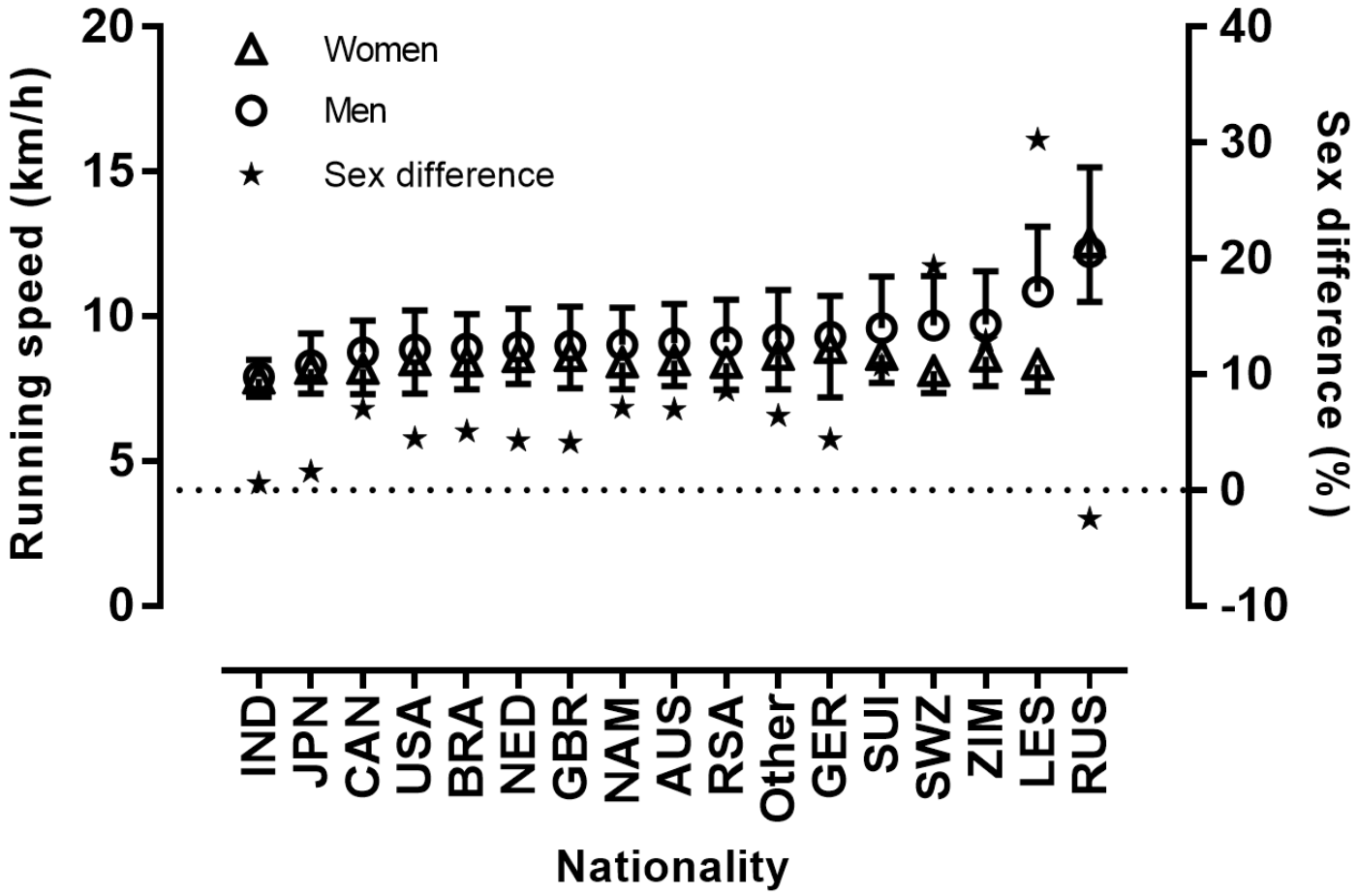
Figure 4 Age by sex and calendar year. All r-values are at $p<0.001$. The dashed lines represent 95% confidence intervals.

Figure 5 Speed by sex and calendar year. Error bars represent standard deviations. The dashed lines represent 95% confidence intervals.

Figure 6 Age of peak performance considering all finishers. Error bars represent standard deviations. The horizontal dashed line is set at 10% of sex difference (right y axis). The dashed lines represent 95% confidence intervals.

Figure 7 Age of peak performance considering the top ten finishers. Error bars represent standard deviations. The dashed lines represent 95% confidence intervals.

526 **Figure 1**
527



528

Figure 2

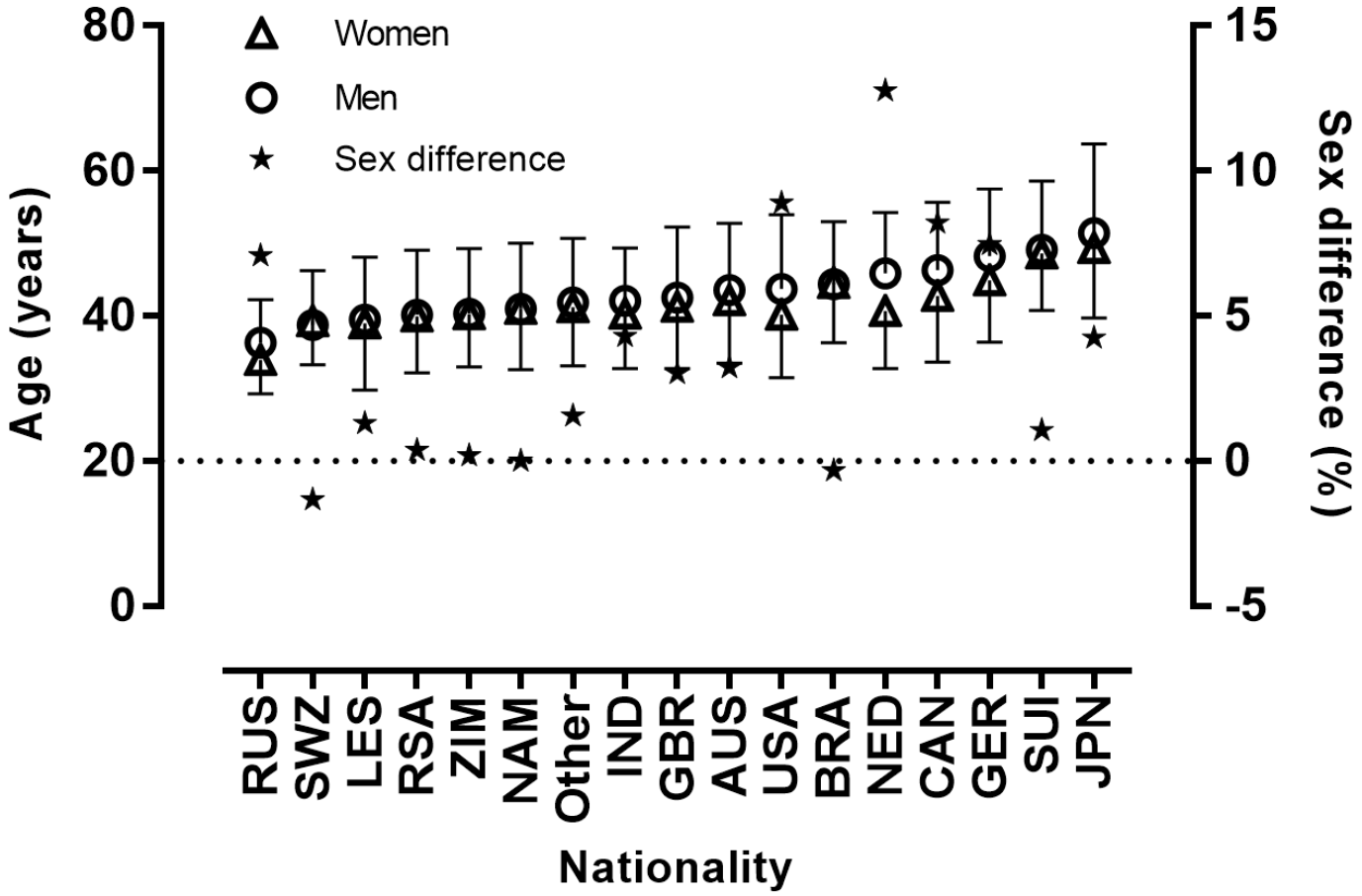

Women
Men
Sex difference
Age (years)
Sex difference (%)
80
60
40
20
0
15
10
5
0
-5
RUS
SWZ
LES
RSA
ZIM
NAM
Other
IND
GBR
AUS
USA
BRA
NED
CAN
GER
SUI
JPN
Nationality

Figure 3

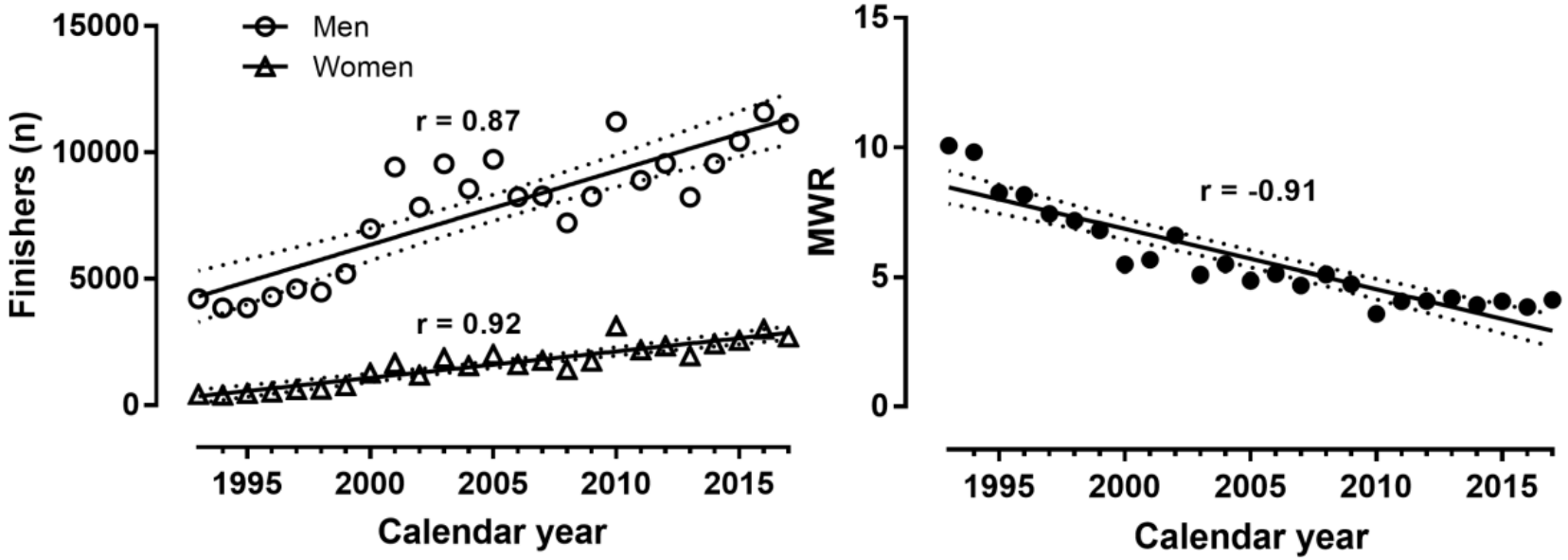

Men
Women
r = 0.87
r = 0.92
Finishers (n)
15000
10000
5000
0
1995
2000
2005
2010
2015
Calendar year
MWR
15
10
5
0
r = -0.91
1995
2000
2005
2010
2015
Calendar year

Figure 4

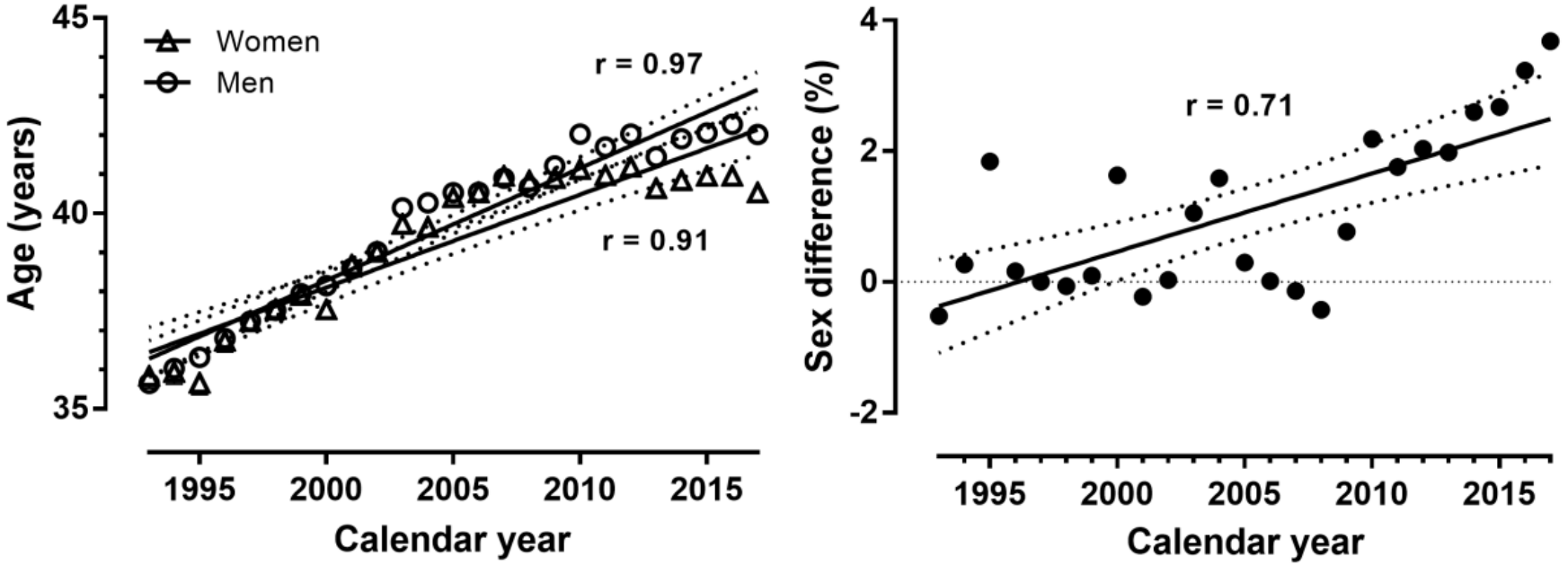
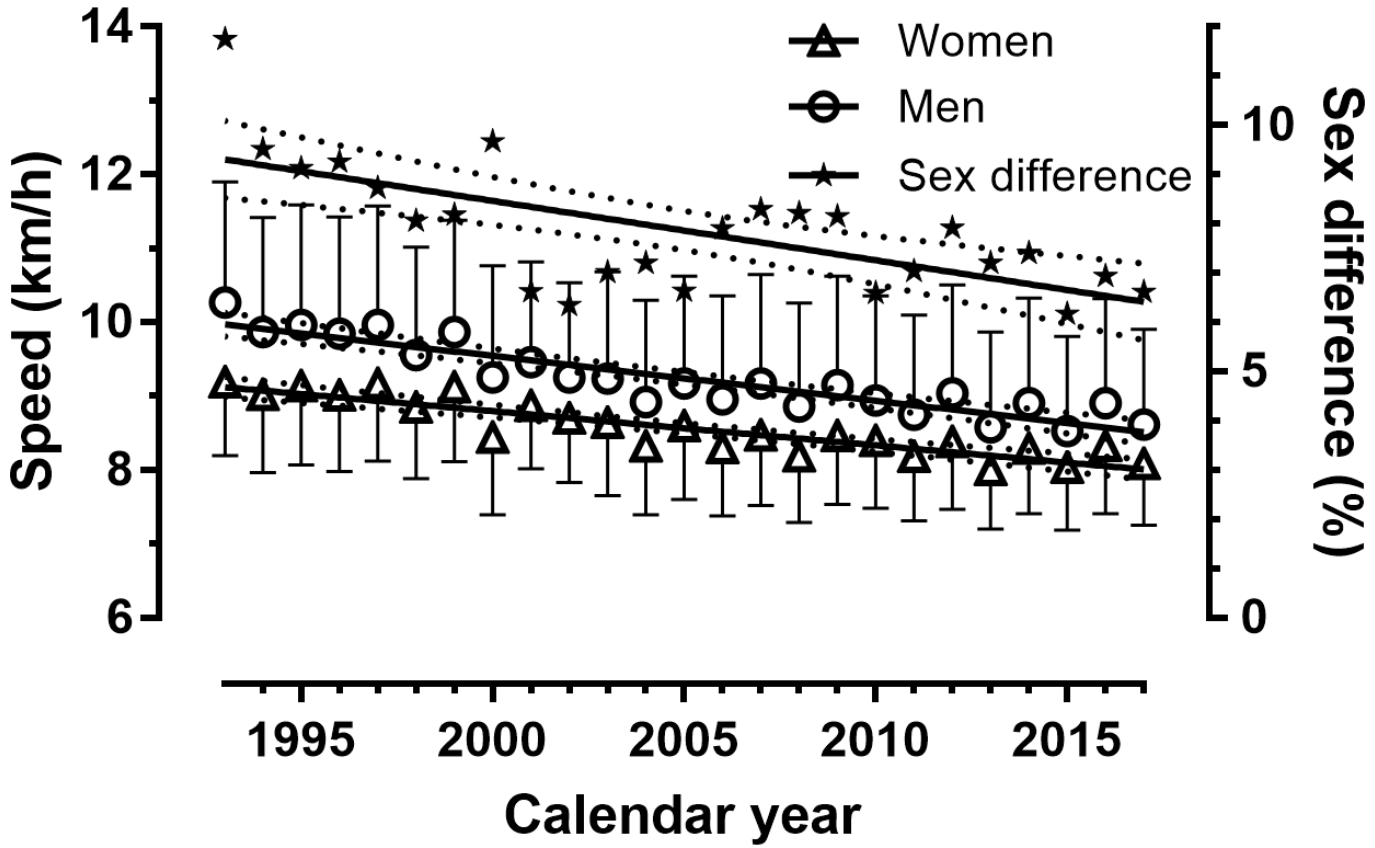
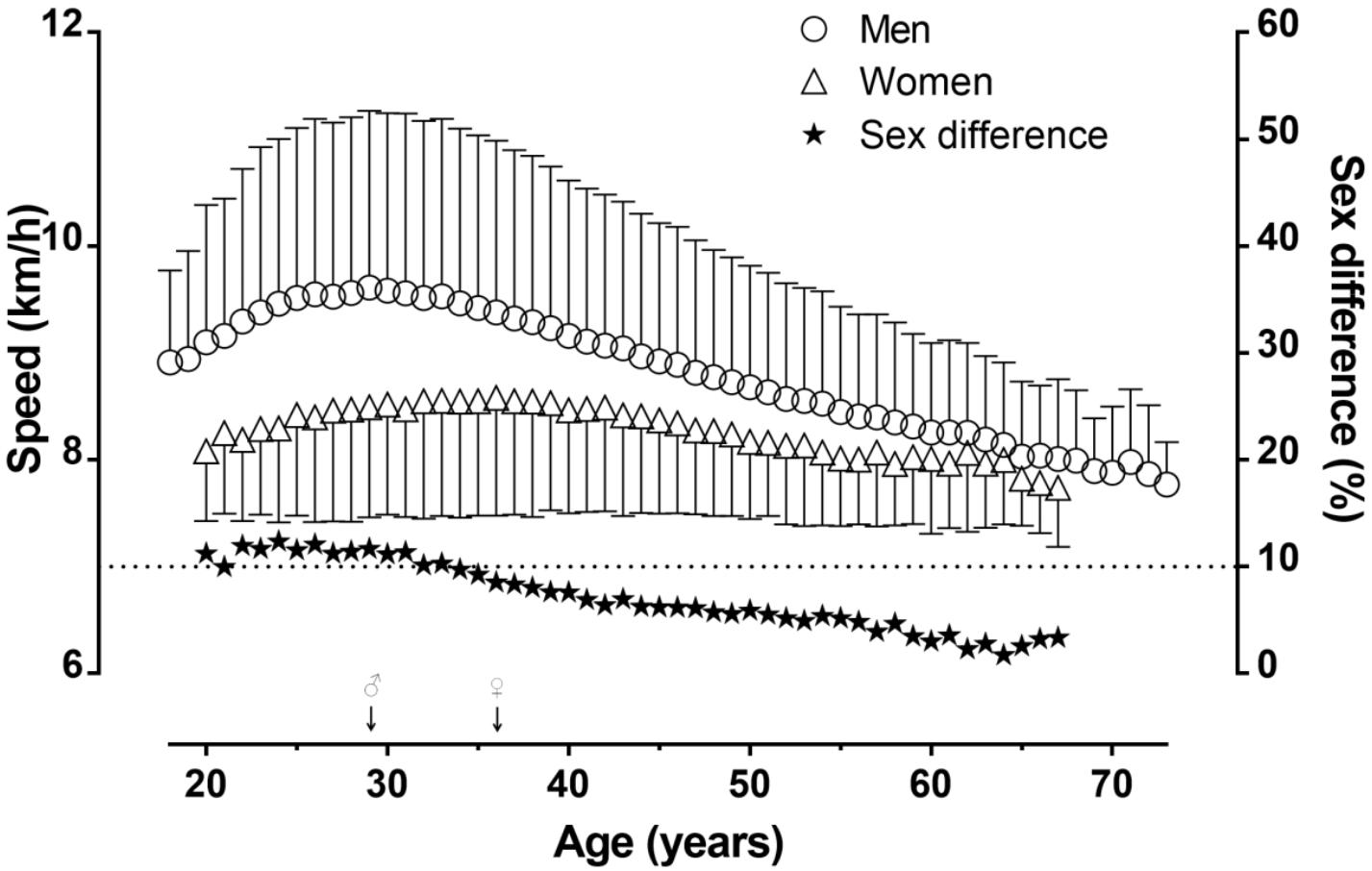

Women
Men
r = 0.97
r = 0.91
Age (years)
45
40
35
1995
2000
2005
2010
2015
Calendar year
Sex difference (%)
4
2
0
-2
r = 0.71
1995
2000
2005
2010
2015
Calendar year

Figure 5

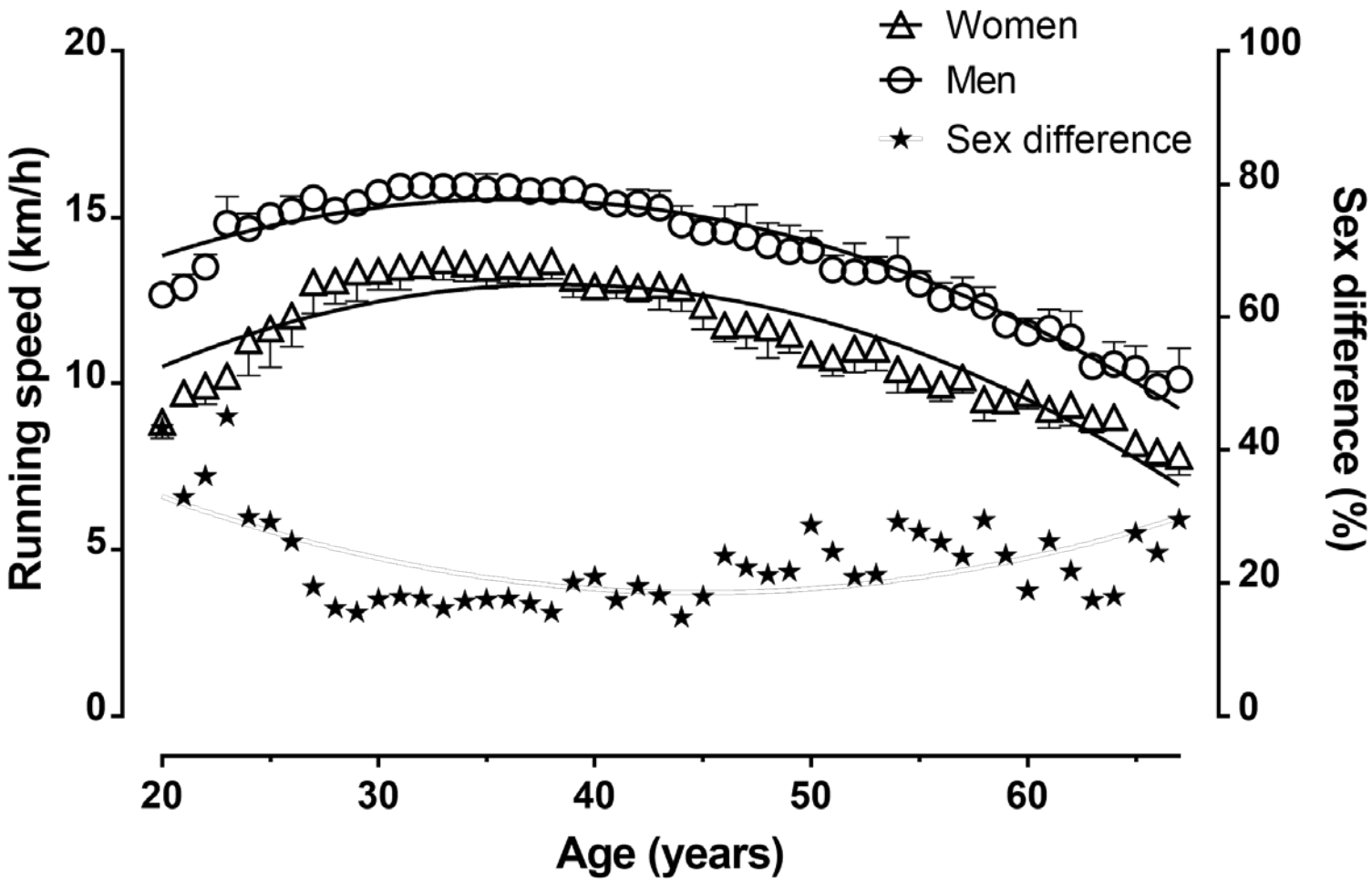

Women
Men
Sex difference
Speed (km/h)
Sex difference (%)
14
12
10
8
6
10
5
0
1995
2000
2005
2010
2015
Calendar year

560 **Figure 6**
561
562



563

564 **Figure 7**
565



566